PSMN1R4-40YLD

N-channel 40 V 1.4 mΩ logic level MOSFET in LFPAK56 using NextPower-S3 technology

26 August 2014 — Product data sheet

1. General description

Logic level gate drive N-channel enhancement mode MOSFET in 175 °C LFPAK56 package using advanced TrenchMOS Superjunction technology. This product has been designed and qualified for high performance power switching applications.

2. Features and benefits

- NextPower-S3 technology delivers ‘superfast switching with soft recovery’
- Low Q_{RR}, Q_G and Q_{GD} for high system efficiency and low EMI designs
- Schottky-Plus body-diode, gives soft switching without the associated high I_{DSS} leakage
- Optimised for 4.5 V gate drive utilising NextPower-S3 Superjunction technology
- High reliability LFPAK (Power-SO8) package, copper-clip, solder die attach and qualified to 175 °C
- Exposed leads can be wave soldered, visual solder joint inspection and high quality solder joints
- Low parasitic inductance and resistance

3. Applications

- Synchronous rectification
- DC-to-DC converters
- High performance & high efficiency server power supply
- Motor control
- Power OR-ing

4. Quick reference data

Table 1. Quick reference data

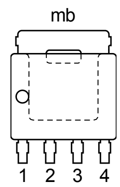
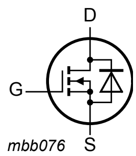
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{DS}	drain-source voltage	25 °C ≤ T_j ≤ 175 °C		-	-	40	V
I_D	drain current	T_{mb} = 25 °C; V_{GS} = 10 V; Fig. 2	[1]	-	-	100	A
P_{tot}	total power dissipation	T_{mb} = 25 °C; Fig. 1		-	-	238	W
T_j	junction temperature			-55	-	175	°C
Static characteristics							
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 25 A; T_j = 25 °C; Fig. 10		-	1.12	1.4	mΩ

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
		V_{GS} = 4.5 V; I_D = 25 A; T_j = 25 °C; Fig. 10		-	1.38	1.85	mΩ
Dynamic characteristics							
Q_{GD}	gate-drain charge	V_{GS} = 4.5 V; I_D = 25 A; V_{DS} = 20 V; Fig. 12; Fig. 13		-	13	-	nC
$Q_{G(tot)}$	total gate charge	V_{GS} = 4.5 V; I_D = 25 A; V_{DS} = 20 V; Fig. 12; Fig. 13		-	45	-	nC

[1] Continuous current is limited by package.

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	S	source	 LFPAK56; Power-SO8 (SOT669)	
2	S	source		
3	S	source		
4	G	gate		
mb	D	mounting base; connected to drain		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
PSMN1R4-40YLD	LFPAK56; Power-SO8	Plastic single-ended surface-mounted package (LFPAK56; Power-SO8); 4 leads	SOT669

7. Marking

Table 4. Marking codes

Type number	Marking code
PSMN1R4-40YLD	1D440L

8. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions		Min	Max	Unit
V_{DS}	drain-source voltage	25 °C ≤ T_j ≤ 175 °C		-	40	V
V_{DSM}	peak drain-source voltage	t_p ≤ 20 ns; f ≤ 500 kHz; $E_{DS(AL)}$ ≤ 200 nJ; pulsed		-	45	V
V_{DGR}	drain-gate voltage	25 °C ≤ T_j ≤ 175 °C; R_{GS} = 20 kΩ		-	40	V
V_{GS}	gate-source voltage			-20	20	V
P_{tot}	total power dissipation	T_{mb} = 25 °C; Fig. 1		-	238	W
I_D	drain current	V_{GS} = 10 V; T_{mb} = 25 °C; Fig. 2	[1]	-	100	A
		V_{GS} = 10 V; T_{mb} = 100 °C; Fig. 2	[1]	-	100	A
I_{DM}	peak drain current	pulsed; t_p ≤ 10 µs; T_{mb} = 25 °C; Fig. 3		-	1201	A
T_{stg}	storage temperature			-55	175	°C
T_j	junction temperature			-55	175	°C
$T_{sld(M)}$	peak soldering temperature			-	260	°C
V_{ESD}	electrostatic discharge voltage	HBM		2	-	kV
Source-drain diode						
I_S	source current	T_{mb} = 25 °C	[1]	-	100	A
I_{SM}	peak source current	pulsed; t_p ≤ 10 µs; T_{mb} = 25 °C		-	1201	A
Avalanche ruggedness						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	$T_{j(init)}$ = 25 °C; I_D = 74 A; R_{GS} = 50 Ω; unclamped; t_p = 0.23 ms; V_{GS} = 10 V; V_{sup} ≤ 40 V	[2]	-	446	mJ
		V_{GS} = 10 V; $T_{j(init)}$ = 25 °C; I_D = 25 A; V_{sup} ≤ 40 V; R_{GS} = 50 Ω; unclamped; t_p = 2.52 ms	[2]	-	1641	mJ

[1] Continuous current is limited by package.
[2] Protected by 100% test

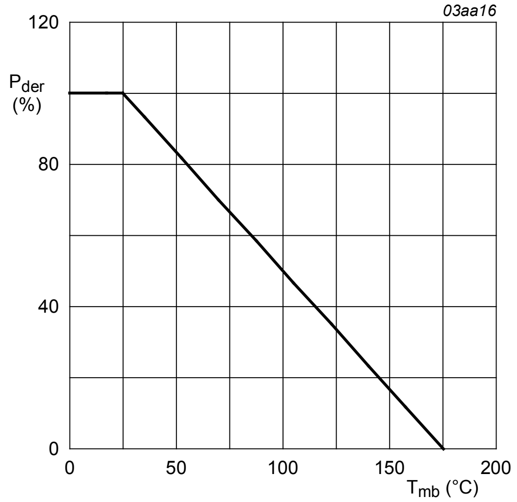
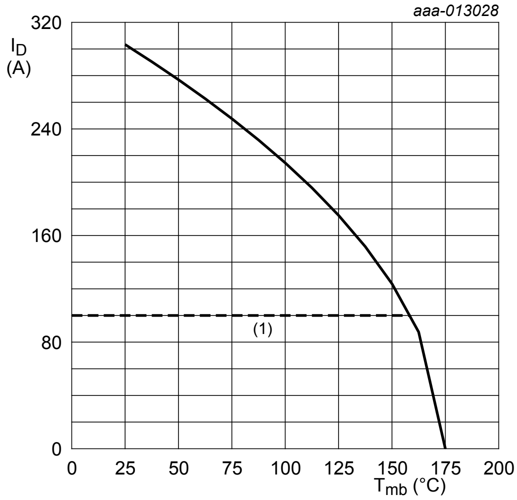


Fig. 1. Normalized total power dissipation as a function of mounting base temperature

$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\,\%$$



(1) Capped at 100A due to package

Fig. 2. Continuous drain current as a function of mounting base temperature

$$V_{GS} \geq 5V$$

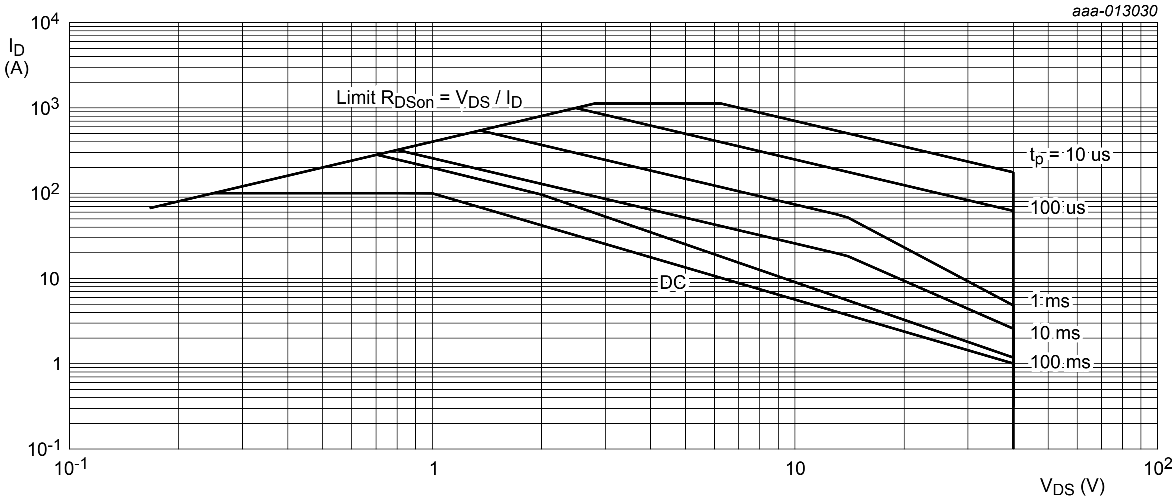


Fig. 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

$$T_{mb} = 25°C;\ I_{DM}\ is\ a\ single\ pulse$$

9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	Fig. 4		-	0.56	0.63	K/W

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	Fig. 5		-	50	-	K/W
		Fig. 6		-	125	-	K/W

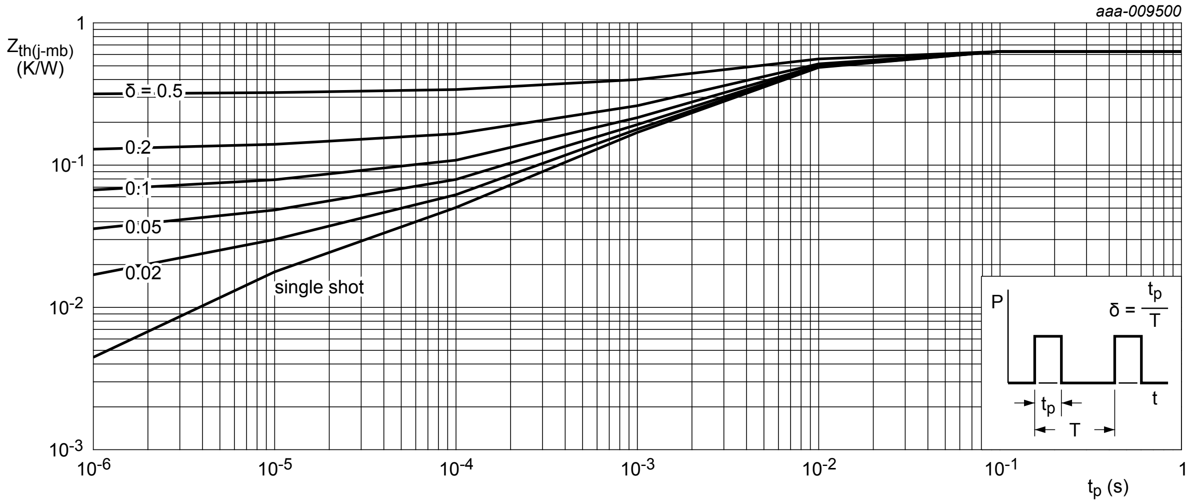


Fig. 4. Transient thermal impedance from junction to mounting base as a function of pulse duration

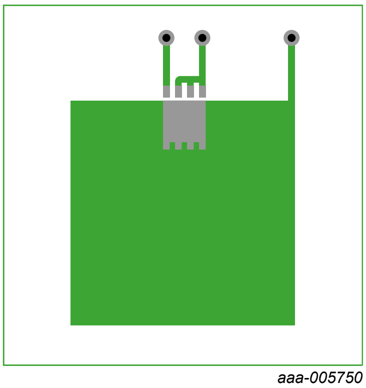


Fig. 5. PCB layout for thermal resistance junction to ambient 1” square pad; FR4 Board; 2oz copper

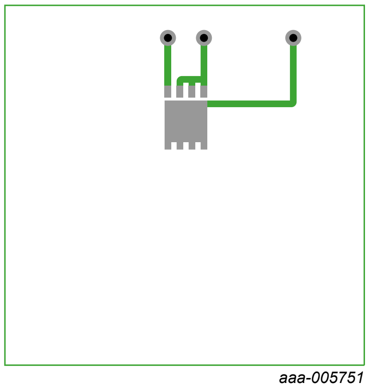


Fig. 6. PCB layout for thermal resistance junction to ambient minimum footprint; FR4 Board; 2oz copper

10. Characteristics

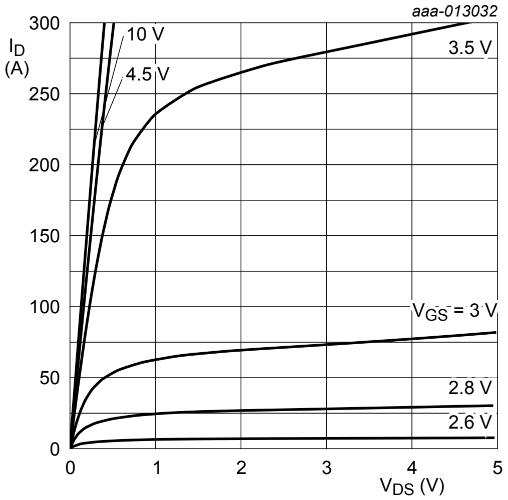
Table 7. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Static characteristics							
$V_{(BR)DSS}$	drain-source breakdown voltage	I_D = 250 µA; V_{GS} = 0 V; T_j = 25 °C		40	-	-	V
		I_D = 250 µA; V_{GS} = 0 V; T_j = -55 °C		36	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	I_D = 1 mA; V_{DS} = V_{GS}; T_j = 25 °C		1.05	1.7	2.2	V

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$\Delta V_{GS(th)}/\Delta T$	gate-source threshold voltage variation with temperature	25 °C ≤ T_j ≤ 150 °C		-	-4.8	-	mV/K
I_{DSS}	drain leakage current	V_{DS} = 32 V; V_{GS} = 0 V; T_j = 25 °C		-	-	1	µA
		V_{DS} = 32 V; V_{GS} = 0 V; T_j = 125 °C		-	12	-	µA
I_{GSS}	gate leakage current	V_{GS} = 16 V; V_{DS} = 0 V; T_j = 25 °C		-	-	100	nA
		V_{GS} = -16 V; V_{DS} = 0 V; T_j = 25 °C		-	-	100	nA
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 25 A; T_j = 25 °C; Fig. 10		-	1.12	1.4	mΩ
		V_{GS} = 10 V; I_D = 25 A; T_j = 175 °C; Fig. 11; Fig. 10		-	-	2.65	mΩ
		V_{GS} = 4.5 V; I_D = 25 A; T_j = 25 °C; Fig. 10		-	1.38	1.85	mΩ
		V_{GS} = 4.5 V; I_D = 25 A; T_j = 175 °C; Fig. 11; Fig. 10		-	-	3.4	mΩ
R_G	gate resistance	f = 1 MHz		-	1.1	-	Ω
Dynamic characteristics							
$Q_{G(tot)}$	total gate charge	I_D = 25 A; V_{DS} = 20 V; V_{GS} = 10 V; Fig. 12; Fig. 13		-	96	-	nC
		I_D = 25 A; V_{DS} = 20 V; V_{GS} = 4.5 V; Fig. 12; Fig. 13		-	45	-	nC
		I_D = 0 A; V_{DS} = 0 V; V_{GS} = 10 V		-	85	-	nC
Q_{GS}	gate-source charge	I_D = 25 A; V_{DS} = 20 V; V_{GS} = 4.5 V; Fig. 12; Fig. 13		-	15	-	nC
$Q_{GS(th)}$	pre-threshold gate-source charge			-	9	-	nC
$Q_{GS(th-pl)}$	post-threshold gate-source charge			-	6	-	nC
Q_{GD}	gate-drain charge			-	13	-	nC
$V_{GS(pl)}$	gate-source plateau voltage	I_D = 25 A; V_{DS} = 20 V; Fig. 12; Fig. 13		-	2.7	-	V
C_{iss}	input capacitance	V_{DS} = 20 V; V_{GS} = 0 V; f = 1 MHz; T_j = 25 °C; Fig. 14		-	6661	-	pF
C_{oss}	output capacitance			-	1543	-	pF
C_{rss}	reverse transfer capacitance			-	299	-	pF
$t_{d(on)}$	turn-on delay time	V_{DS} = 20 V; R_L = 0.8 Ω; V_{GS} = 4.5 V; $R_{G(ext)}$ = 5 Ω		-	39	-	ns
t_r	rise time			-	49	-	ns
$t_{d(off)}$	turn-off delay time			-	47	-	ns
t_f	fall time			-	30	-	ns

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Q_{oss}	output charge	V_{GS} = 0 V; V_{DS} = 20 V; f = 1 MHz; T_j = 25 °C		-	50	-	nC
Source-drain diode							
V_{SD}	source-drain voltage	I_S = 25 A; V_{GS} = 0 V; T_j = 25 °C; Fig. 15		-	0.78	1.2	V
t_{rr}	reverse recovery time	I_S = 25 A; dI_S/dt = -100 A/µs; V_{GS} = 0 V; V_{DS} = 20 V; Fig. 16		-	47	-	ns
Q_r	recovered charge		[1]	-	61	-	nC
t_a	reverse recovery rise time	I_S = 25 A; dI_S/dt = -100 A/µs; V_{GS} = 0 V; V_{DS} = 20 V; Fig. 16		-	25.4	-	ns
t_b	reverse recovery fall time			-	21.7	-	ns

[1] includes capacitive recovery



T_j = 25 °C

Fig. 7. Output characteristics; drain current as a function of drain-source voltage; typical values

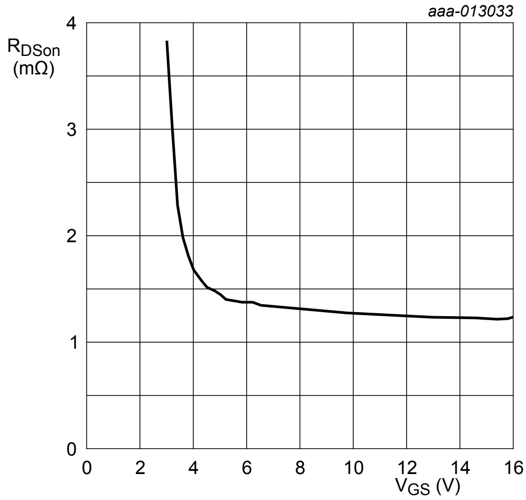


Fig. 8. Drain-source on-state resistance as a function of gate-source voltage; typical values

$T_j = 25°C;\ I_D = 25A$

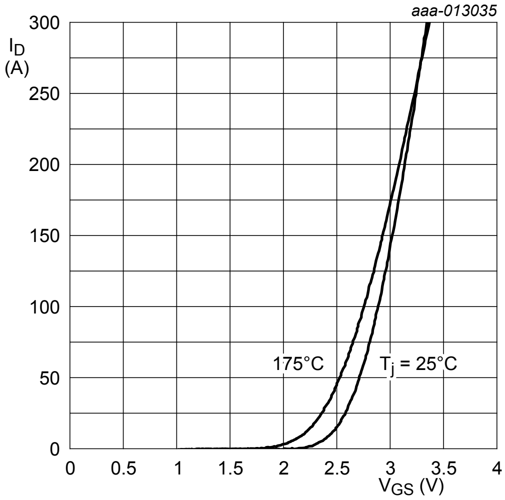
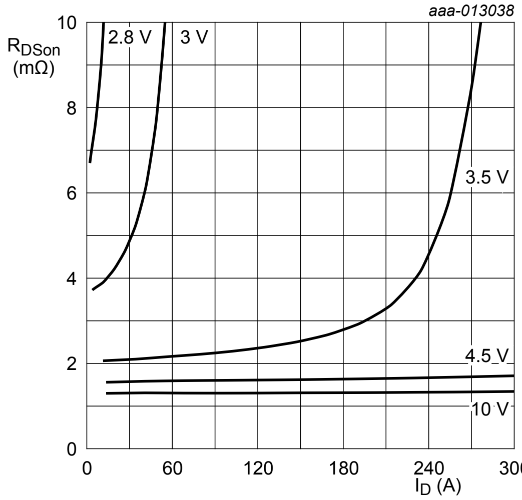


Fig. 9. Transfer characteristics; drain current as a function of gate-source voltage; typical values

$$V_{DS} = 10V$$



T_j = 25 °C

Fig. 10. Drain-source on-state resistance as a function of drain current; typical values

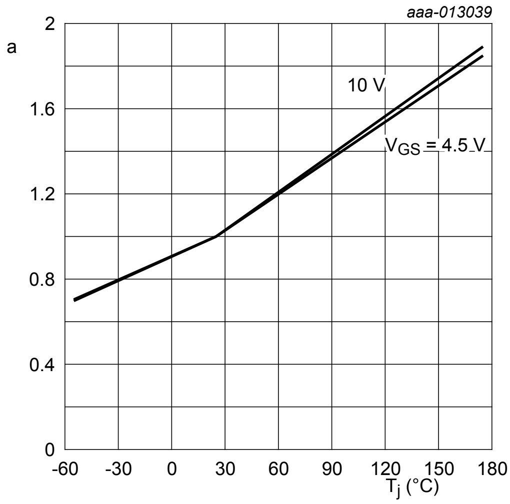


Fig. 11. Normalized drain-source on-state resistance factor as a function of junction temperature

$$a = \frac{R_{DSon}}{R_{DSon\,(25°C)}}$$

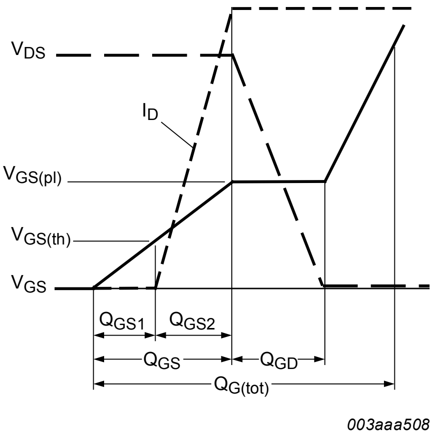


Fig. 12. Gate charge waveform definitions

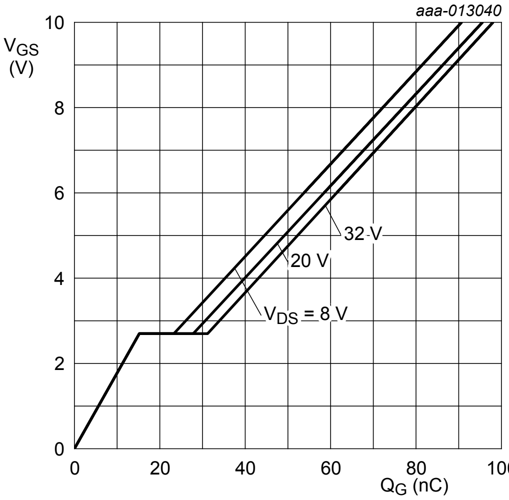


Fig. 13. Gate-source voltage as a function of gate charge; typical values

$T_j = 25°C;\ I_D = 25A$

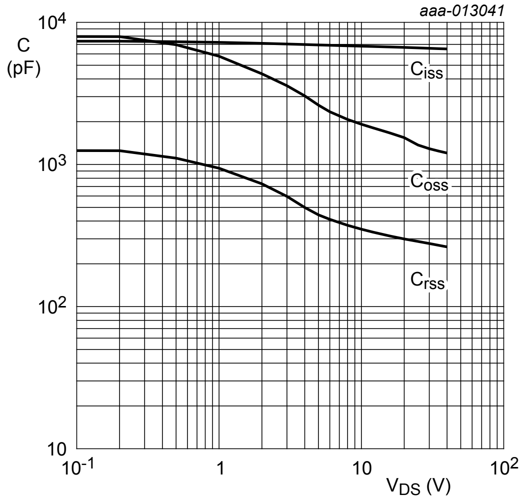


Fig. 14. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

$V_{GS} = 0V;\ f = 1MHz$

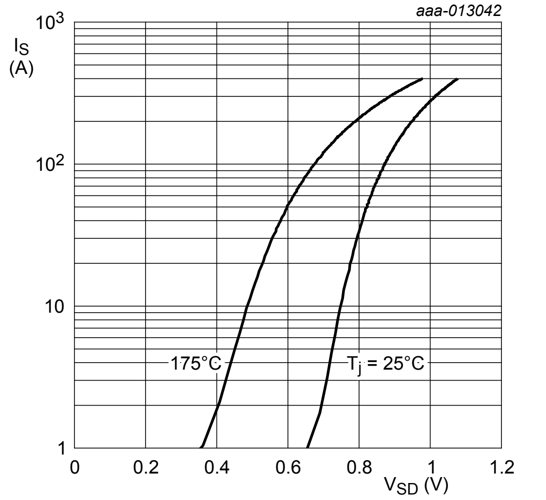


Fig. 15. Source current as a function of source-drain voltage; typical values

$V_{GS} = 0V$

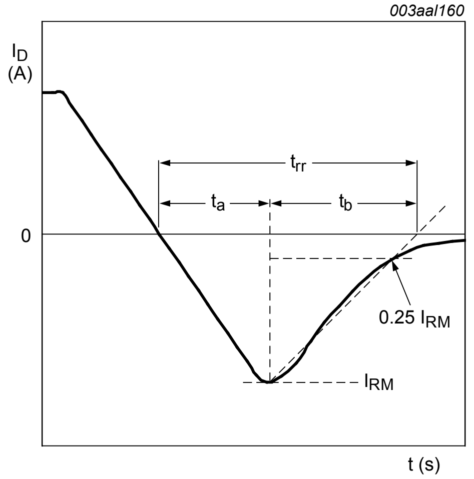
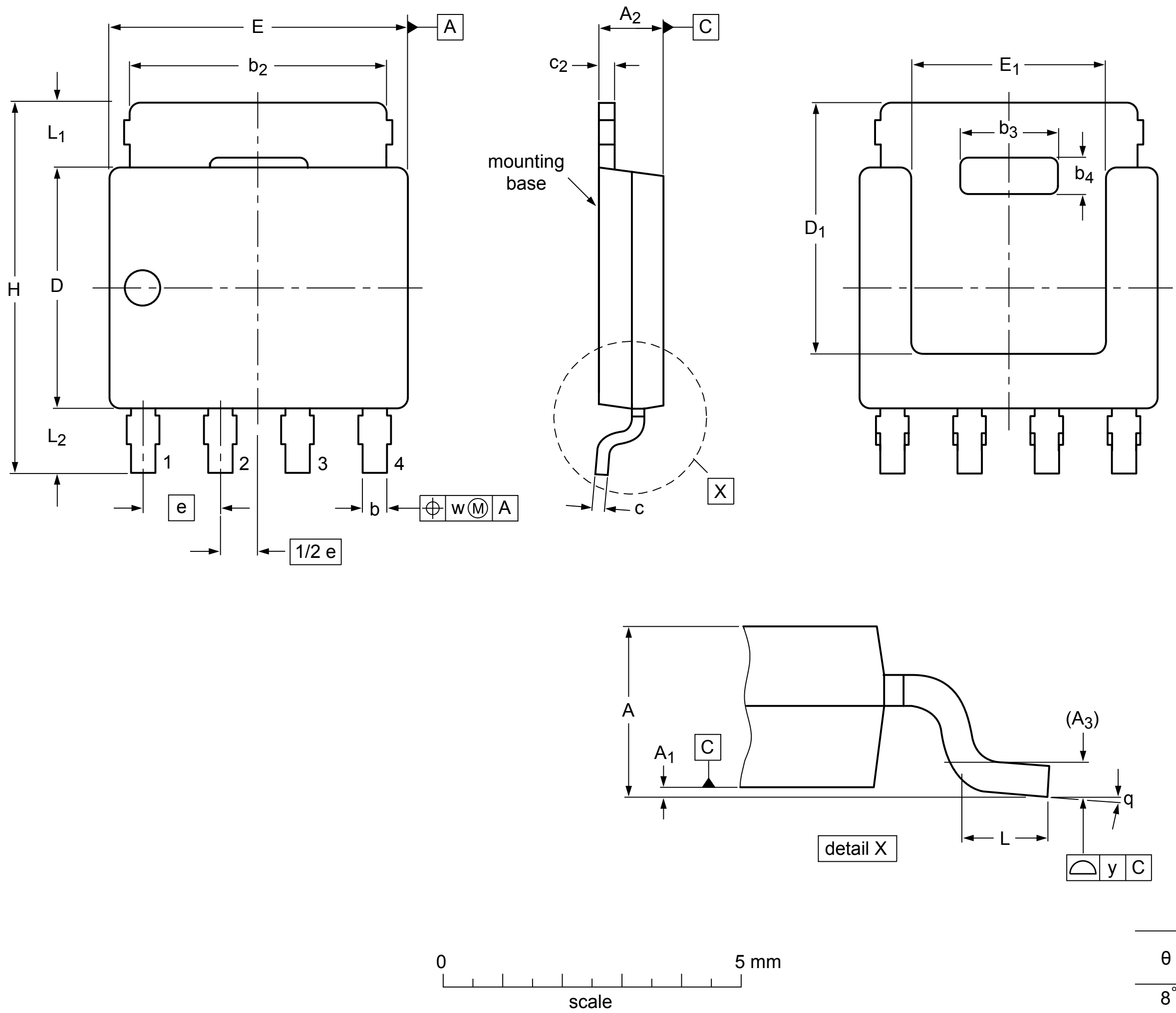


Fig. 16. Reverse recovery timing definition

11. Package outline

Plastic single-ended surface-mounted package (LFPAK56; Power-SO8); 4 leads **SOT669**



Dimensions (mm are the original dimensions)

Unit(1)		A	A_1	A_2	A_3	b	b_2	b_3	b_4	c	c_2	D(1)	D_1(1)	E(1)	E_1(1)	e	H	L	L_1	L_2	w	y	θ
mm	max	1.20	0.15	1.10		0.50	4.41	2.2	0.9	0.25	0.30	4.10	4.20	5.0	3.3		6.2	0.85	1.3	1.3			8°
	nom				0.25											1.27					0.25	0.1	
	min	1.01	0.00	0.95		0.35	3.62	2.0	0.7	0.19	0.24	3.80		4.8	3.1		5.8	0.40	0.8	0.8			0°

Note
1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

sot669_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT669		MO-235				~~11-03-25~~ 13-02-27

Fig. 17. Package outline LFPAK56; Power-SO8 (SOT669)

12. Legal information

12.1 Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
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13. Contents

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Date of release: 26 August 2014